

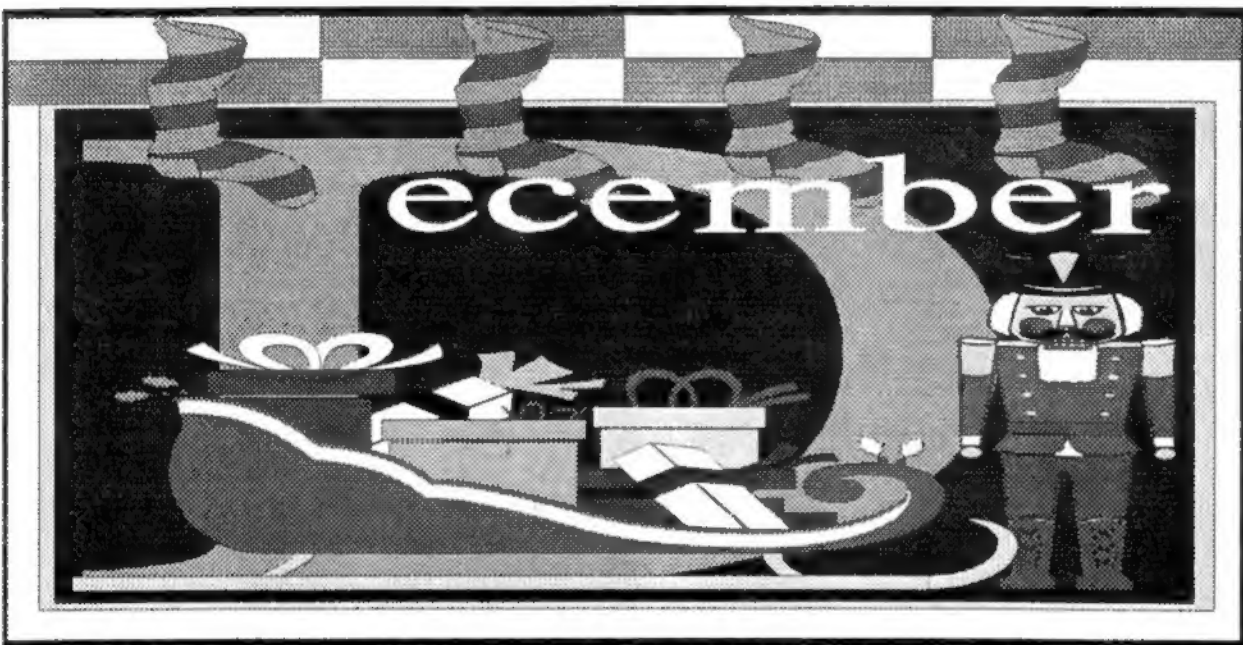
12/96

Happy Hollidays!!!

from UARC



ARRL
CLUB
#1602



ISSUE

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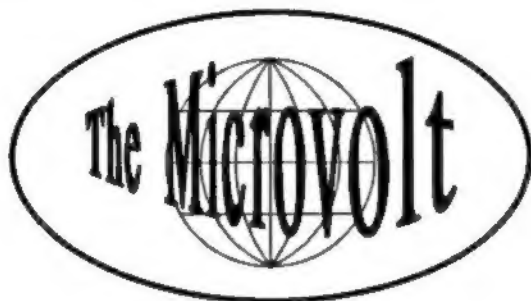
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The Utah Amateur Radio Club was organized under it's present name in 1927, although its beginnings may date back as early as 1909. In 1928, it became affiliated with the American Radio Relay League (club #1602) and is a non-profit organization under the laws of Utah. It holds a club station license with the call W7SP, a memorial call for Leonard (Zim) Zimmerman, an amateur radio pioneer in the Salt Lake City Area. The club meets each month except July and August. The meetings are held on the first Thursday of the month at 7:30 PM in the Exhibition hall located on the Salt Lake County Fairgrounds just south of Murray City Park. Club membership is open to anyone interested in amateur radio; a current license is not required. Dues are \$13 per year, including a MICROVOLT subscription. Those living at the same address as a member who has paid \$13 may obtain a membership without a Microvolt subscription for \$9. ARRL membership renewals should specify ARRL Club #1602. UARC maintains the following repeaters: 146.62 (mineas) and 449.10. The repeaters are administered by the UARC repeater committee. Comments and questions may be directed to any committee member. The Lake Mountain repeater (146.76 mineas offset) has Autopatch facilities on both the Orem exchange (covering Satequin to Lohi) and the Salt Lake City exchange (covering Draper to Layton). The 449.10 repeater has autopatch facilities into Salt Lake City only. Due to the volume of traffic, only mobiles should use this autopatch. Autopatch use is open to all visitors to our area and to all club members. Non members who wish to use the Autopatch are encouraged to help with and maintaining a club membership. THE MICROVOLT: The Microvolt is the official publication of the club. Deadline for submissions to the Microvolt is the 10th of each month prior to publication, except Aug. All submissions are welcome but what is printed and editing are the responsibility of the UARC board. Reprints are allowed with proper credits to the MICROVOLT, UARC, and authors.



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1996 ISSUE #12

632 University Street, Salt Lake City, Utah 84102

Volume XL Number 12



1997 Club Officer Nominations are OPEN!!

As if you haven't had enough of elections, it is time for all our members to consider the officers for your 1997 UARC board. The Nominations Committee has a few good ideas and we welcome your good ideas as well. If you or someone you know is interested on serving on the board, just speak to one of the current board members. There are also several committees that can use your helping hands as well.

To be a part of the Board, you must be a dues paid member, in good standing. The President must have been a member, in

good standing for at least one year. For the protection of the funds, the current board also does a light back ground check on all nominees. The Secretary and Treasurer need computer and bookkeeping or database backgrounds. The Microvolt Editor needs a computer, time (and nerves of steel) and an internet address has become a very useful tool also. Board members attend all meetings and functions you possibly can. These usually are: the monthly UARC meeting the first Thursday of the month. The board meets the following week. Help with Steak Fry in July and Field Day in June.

Our next general meeting will be open nominations and elections. There has been people suggested by the nominations com-

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mittee and they are listed inside. We welcome your solutions, suggestions and willing hands.

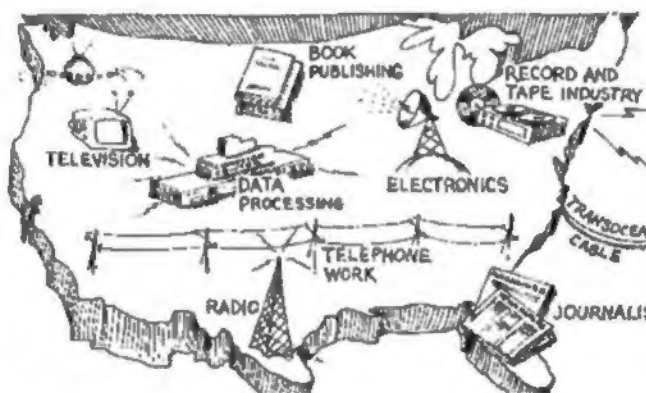
On a personal note, it has been a privilege and a great deal of fun serving on the UARC board. I have a great deal of admiration, respect and appreciation for the people I have worked with. It is a good experience and addition to my life. I look forward to this next year

Cindy Peters, KB7OUT

MARSHALL QUIAT, AG0X

The Rocky Mountain Division Director of the American Radio Relay League (ARRL) has been re-elected by a vote of 1490 to 768. Marshall Quiat, AG0X, campaigned on a platform of responsiveness to members' wishes, and won an easy victory over Gunnar Carlson, AE4W, of Las Cruces, New Mexico. The votes were counted by a Committee of Tellers on Friday, November 15. Carlson's campaign had advocated a more radical position including changing the way officers of the League are chosen and strong advocacy of continuing the Morse Code requirement for HF licensing.

The ARRL is governed by a Board of 16 Directors, each elected by the ARRL members in a different "division," a particular region of the country. The Board makes all policy decisions and chooses the officers and General Manager. Utah is part of the Rocky Mountain Division which also includes the states of Colorado, New Mexico, and Wyoming.



FCC HAS SOME BAD DAYS

The FCC's Gettysburg office, which issues all amateur licenses, had its share of problems during late October and early November. First, their computer was out of service for almost a week, and no new licenses were issued. Then, on October 29, a big file of newly-issued licenses appeared on Internet, and it seemed the problem was solved. At least it seemed that way for a few hours. Then the telephone calls started arriving saying that many of the newly-is-

sued calls had already been issued a week earlier, but to different operators. Before the morning was very old, the new file disappeared, and more computer problems were reported.

Particularly affected in Utah, were those who passed the tests for new licenses or upgrades at the November 20 session in Provo. They found that some of the new calls they had been using now appeared in the database as belonging to someone else. A bulletin stated that all licenses issued after the 24th were invalid, as most of them were erroneous. The Provo licenses had been issued on the 23rd, but they seemed to be involved in the problem as well, since they no longer appeared in the database at all.

Resolution finally came on November 5 when the whole set of transactions was re-done. Most people who had received new calls after the 21st had to accept still newer calls on November 5. In some cases the November 5th data showed the same call being issued a third time.

The anomalies happened at just about time the FCC had planned to issue the vanity callsigns for applications received on the first day of "Gate 2." (Gate 2 allowed any Extra Class operator to apply for a call of his own choosing.) The Commission said the computer problems were not related to the vanity callsigns.

The latest bulletin about vanity calls says: The FCC calls them WIPS—"works in process"—applications that need some kind of special handling. But for up to 12 per cent of first-day Gate 2 vanity call sign applicants, WIPS means "no new call sign." It now appears that as many as 550 first-day applications ended up in the WIPS pile for a variety of "inconsistencies"—some as simple as an address on an application that failed to match one already in the FCC's database. The FCC said this week that it hopes to clear its decks of all first-day vanity WIPS by November 15. An FCC spokeswoman in Gettysburg says that being in the WIPS stack does not necessarily mean you "missed out" on getting one of your call sign choices. Depending on the WIPS category (the FCC's not telling what those are), a new call sign already may have been attached to many of the applications that are being held up. New Gate 2 grants since November 4 have brought the grand total of successful applicants to 3805.

It's now estimated that some 200 first-day Gate 2 applications were dismissed by the FCC, most because all of the applicants' call sign choices already had been granted to other hams. Still, many 1x2 call signs remain. As of this week, more than 6000

1x2 calls in all US districts remained available—substantially more than the number of vanity call signs the FCC has issued under Gate 2 to date.

Still not known is just when Gettysburg will process Gate 2 applications that were received after September 23, the opening day for Gate 2. An FCC spokeswoman said this week she had "no idea" when that would happen. Applications from approximately 1400 hams arrived at the FCC in the days following the opening of Gate 2. Although the FCC did not release the initial day-one grants until Tuesday, November 5, the applications actually were processed—and the licenses dated—on November 4. The FCC spokeswoman said that computer problems on the morning of November 5 prevented the release of the database file until late that afternoon.

UTAH HAMFEST '97



Utah Hamfest '97 is alive and well!! Mark your calendar for April 12, 1997. Hamfests have a swapmeet and much, much more!! There will be seminars, dealers, fun and games and a chance to meet many of your friends from the airwaves and your ARRL representatives. And of course--PRIZES!!

We welcome those who would like to be a part of the committee and look forward to seeing you there. Questions: call Cindy Peters, KB7OUT. 268-4410

DECEMBER MEETING:

THE MEMBERS SPEAK

It's that meeting of the year when *you* provide the program. You get to choose officers for the coming year and decide what you would like the club to do and where you would like to fit into it.

The next meeting of the Utah Amateur Radio Club will be Thursday, December 5, at 7:30 p.m., in the Little Theater building on the Salt Lake County fairgrounds (approximately 175 east on 5150 South). It will feature election of officers for the coming year and a chance to discuss where the club be going and what it should be doing in 1997. If there is a program you would like to see the club undertake and you would like to spearhead it, this meeting will be the perfect time to volunteer.

As we go to press, the following nominations for office stand, being the results of the nominating committee's deliberations and nominations obtained from the floor at the November meeting:

For President: Alan Seyboldt, KC7MUZ

For Executive Vice-President:
Cindy Peters, KB7OUT

For Vice-President:
Gordon Smith, K7HFV

For Secretary: Gary Openshaw, KC7AWU

For Treasurer: Chuck Johnson, WA7JOS
For Program Chairperson: Linda Reeder, N7HFV
Jack Warren, KC7KEL

For Microvolt Editor Cokie Eddy, KC7MDV
For Assistant Editor:
Maurine Streckenfinger, KC7HOZ

This slate, if elected, would make for surprisingly little change in the makeup of the Board of Directors. All the nominees are

the incumbents for the indicated offices with the exception of Alan Seyboldt who is currently one of the program chairpersons and Jack Warren who would be joining the Board for the first time. A tenth member of the Board would be Bruce Bergen, K17OM, as Immediate Past President.

Before elections, nominations from the floor will again be accepted. The one stipulation is that no one can be nominated without his consent. If you are planning to nominate someone, be sure to confirm in advance that he is willing to run.

The December meeting is your chance to be heard. Don't miss it!

COKIE...

...IS HAVING A MOVING EXPERIENCE!!



Cokie Eddy, KC7MDV, your normal Microvolt Editor, found herself in the throes of moving at Microvolt deadline time this month. She and her husband, Dave, are moving from West Jordan to Dugway Proving Ground. She expects to have her computers back up and working again in time for the January issue, (assuming, of course, she is elected at the coming meeting). That issue should contain the latest addresses and phone numbers for reaching her. Her e-mail address, however, remains the same, so anyone anxious to submit material right away can do so.

Meanwhile, this issue is being prepared by a group of previous editors: Cindy Peters, KB7OUT; Gordon Smith, K7HFV; and Jerry Bennion, WR7N, with additional materials by Eugene McWherter, N7OVT and Carol McWherter, KC7LLW. We are prepared not only to retract anything printed here, but also to deny we ever said it.

REPEATER NEWS

If you have discovered lately that you can't get into your favorite repeater any more, the problem might be that the repeater now requires you to transmit a CTCSS or "PL" tone. Several repeaters in the area have added a CTCSS requirement over the last several months. Here is a rundown:

147.18 (Snowbird)	100.0 Hz
147.02 (Bear Lake)	100.0 Hz
146.94 (Salt Lake)	100.0 Hz
146.88 (Salt Lake)	88.5 Hz
146.82 (Kaysville Pk)	123.0 Hz
146.90 (Little Mtn.)	123.0 Hz
146.92 (Ogden)	123.0 Hz
145.49 (Promontory Mtns)	123.0 Hz

All of these repeaters continue to be open to all users. The tone requirement has been added simply to avoid interference from other transmitters at the repeater sites.

The Bear Lake repeater that was formerly on 147.12 has now been moved to 147.02, where there will be no overlap with the Salt Lake repeater on the same frequency. The 147.12 frequency will likely be re-used for a local-coverage repeater in the Bear Lake area.

The Snowbird system now includes the 146.80 repeater on Blowhard Peak east of Cedar City. The system also includes the 147.02 (Bear Lake), 146.94 (Milford), 146.82 (Utah Hill near St. George), and 147.12 (Salt Lake). Las Vegas stations are often heard using the Utah Hill repeater. The operators of the Snowbird system ask that operators limit their QSOs on the system to about ten minutes, owing to the large number users.

The 146.88 repeater is operated by Salt Lake County ARES. They ask that it be used only as a calling repeater and not for QSOs. Of course it may be pressed into service during an actual emergency or during ARES exercises.

WHAT YOUR S-METER CAN DO

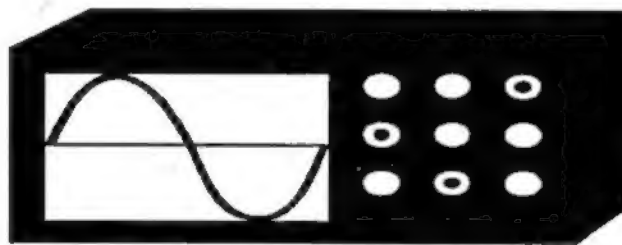
Let's suppose there's an unidentified station on the '62 repeater making obscene noises, or just keying his carrier at precisely the right times to cause the most disruption to QSOs going on. What do we do about it? One obvious answer is we can all get equipped with some good DF

gear that will give us bearings and see where they cross on the map. We have had some UARC meetings where systems were demonstrated and books recommended, but

the number of equipped stations remains low. Well, getting equipped with DF gear and learning how to use it is still something to be highly recommended. But while we're waiting for that happy day, there are still some things we can do with some simpler equipment additions, or even with things we already have.

Many radios have a signal strength indicator. It may be an actual S-meter, or it may be a bar graph made of LCD or LED segments. This indicator can be an important tool in locating a jammer.

Measuring signal strength may sound pretty pedestrian, inaccurate, and not too useful. But it can actually be a valuable component of the strategy for finding intruders.



One thing signal strength has going for it is that everyone with an S-indicator on his radio is already equipped to take measurements. Sometimes having a "lot" of data points can partially make up for not having very much information per point. Given the large number of operators in the Salt Lake Valley, getting a lot of points is well within our grasp. If hundreds of stations could all take readings on a mystery jammer, his location can be identified fairly closely from this information alone.

To participate in such a program, the first step is to get acquainted with the reverse switch on your radio. It is important to realize that when they're talking on a repeater, the signal strength indicator is telling you about the strength of the "repeater's" transmitter, not the user's transmitter. To see if you can hear a user and measure how strong he is you must be listening to the repeater "input", not to the output where we normally listen. The reverse switch makes this change quickly. It reverses the transmit and receive frequencies. Remember to re-reverse, though, before you transmit. Otherwise, you will be transmitting on the output frequency rather than through the repeater.

Get experience listening to simplex signals or signals on repeater inputs. Use your reverse switch often, on a wide variety of stations, so that you have a feel for what signal strengths to expect from different parts of your valley, or from neighboring valleys.

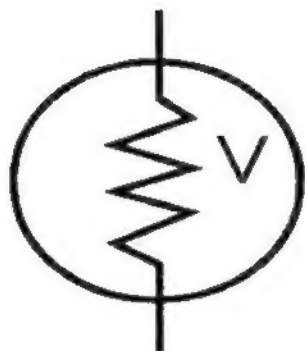
One of the first steps in locating a signal is simply to determine which city it is coming from, and this is an area where signal strength readings really shine. If a mobile starts out to DF the signal, but he can't hear it at all at his starting point, then he has to just start driving randomly in some direction or another hoping he'll get to a

point where the signal is at least a little above the noise level. If, however, he starts out armed with signal strength reports from various cities, he may know that the signal is strong in Bountiful, but uncopiable in Provo. Just that piece of information can save hours of hunting.

One problem you will probably encounter with signal strength readings, is that many stations you hear may be full scale on your indicator. A wide range of signals all produce the same full-scale reading, so the reading doesn't give much information. Because our radios are made to detect frequency modulation, the manufacturers go to some pains to remove amplitude variations so that we can hear the signal with a better signal-to-noise ratio. But when we want to measure signal strength, amplitude variations are the very thing we're looking for. A radio may be able to receive signals over a range of signal strengths from a fraction of a microvolt to, say, 500,000 microvolts or more. Most strength indicators, though, hit full scale at a few tens of microvolts. So over most of the range the receiver can detect, its S-indicator is on the pin and is not giving any useful information.

There are several ways around this problem. One way is simply to use a multi-mode radio. These radios have to preserve amplitude variations for use on CW or single sideband, and generally have a much wider range of useful meter readings than FM rigs have. If you have an HF radio, you can use it to receive on two meters by just adding a receiving converter. These can be purchased ready-made, built from kits, or built from scratch, at quite reasonable prices.

But if you don't have a multi-mode radio or any plans to get one soon, then you must rely on one of the means of reducing the signal into your FM radio, to get the S-



indicator back in a useful range. Step attenuators make a good way to do this. You simply insert one between your radio and its antenna, and then adjust its knobs or switches until the signal in question is

somewhere in the middle of the S-indicator's range. Attenuators can be built from designs in the handbook, and they often turn up at swap meets and in surplus catalogs. Another trick that often works is just to tune the receiver off frequency. Set the tuning step size in your radio to 5 kHz, or as low as it will go. Then if a signal lights all your bars, just start tuning off frequency until your indicator gets back into some sort of middle ground.

It will be helpful to keep a record of the strengths of various stations at known locations. If you used an attenuation trick, don't forget to record it as well. You might enter, for example, that W7LID in Sandy was 4 bars with 20 dB of attenuation in, or that he was S-5 with the receiver 15 kHz off frequency. Then when you hear an unknown station from the same receiving location, your first suspicions might be that it is in one of the areas that produce the

about the same signal strength.

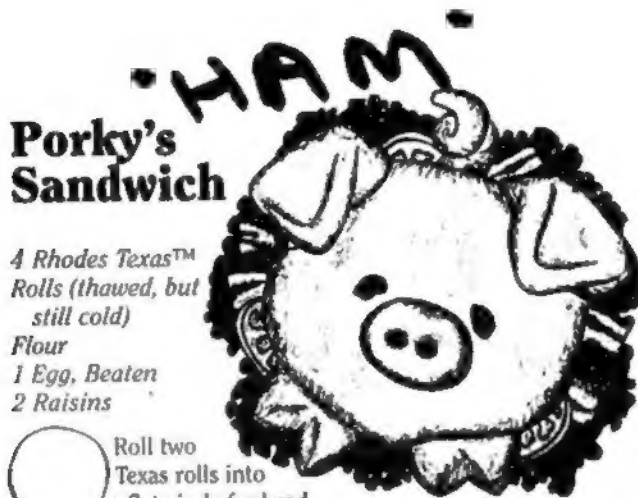
If a signal stays on for a long time or keys frequently over an hour or more, you can actually drive right to the location with nothing more than signal strength information. If the land were flat and there were no shadows or multi-path, you could just drive along an east-west line until the signal peaks. Then, from this point, drive along a north-south line until the signal peaks again. A couple of repetitions of those steps should put you right in front of the jammer's house. Sometimes it isn't quite that easy because the land isn't flat, there *are* reflections, and there are shadows. But the signal strength approach is actually bothered less by these imperfections than is direction-finding. The biggest pitfall to watch out for is the one of seeing the signal strength increase as you go uphill and deciding you're closing in on the mystery station. The increase may be just because you are getting to a better vantage point. Once you've learned what signal strength to expect from a station a block or two away using your particular setup, though, you'll be able to tell the difference. Just remember to ask the question, "Is it getting stronger because I'm getting closer, or just because I'm getting above obstructions." With a little practice, you can make your S-indicator an important weapon in the fight against jammers.

EXAMINATION SCHEDULE

Date	Location	Contact Person	Home Ph.	Bus. Ph.
12/07/96 (Sat.)	Salt Lake C	Gordon Smith, K7HFV	582-2438	534-8116
12/18/96 (Wed.)	Provo	Steve Whitehead, NV7V	465-3983	225-5200
01/04/97 (Sat.)	Ogden	Matt George, AB7GM	627-6064	774-9990
01/13/97 (Mon.)	Delta	Stephen Bowes, KB7SSF	864-5936	
01/22/97 (Wed.)	Provo	Steve Whitehead, NV7V	465-3983	225-5200
01/28/97* (Tues.)	Salt Lake C	Eugene McWherter, N7OVT	484-6355	
02/08/97 (Sat.)	Salt Lake C	Gordon Smith, K7HFV	582-2438	534-8116

*Only Novice and Technician elements (1A, 2, and 3A) given at this session.

"Ham" Radio has many fine traditions. Carol, KC7LLW found these two holiday treats that just may reflect the fun spirit of our hobby. Enjoy!!!



Porky's Sandwich

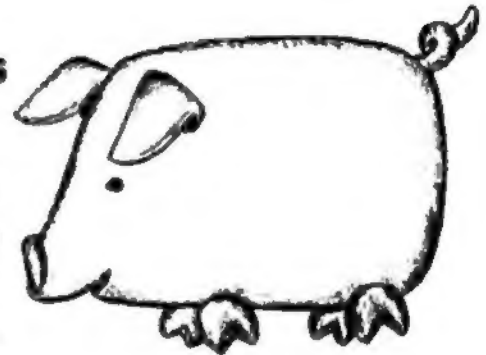
4 Rhodes Texas™
Rolls (thawed, but
still cold)
Flour
1 Egg, Beaten
2 Raisins

Roll two Texas rolls into a flat circle for head. Roll one Texas roll into rectangle shape and cut in half diagonally to make two triangles. Press short base of triangles down into top of head and flop over for ears. Cut one Texas roll in half. Cut in half again and form two tear-drop shapes and slice as shown for toes. Position under head. Divide remaining half in two. Roll one piece into rope and curl for tail. Place above head. Form last piece into a flat circle and cut out nostrils with the end of a straw, position on face. Add raisins for eyes. Brush with beaten egg and allow to rise for 30 minutes. Just before baking, widen nostrils again with straw or a clean pencil eraser. Bake at 350°F for 20 minutes. Allow to cool. Slice horizontally. Spread with mayonnaise. Layer with lettuce, tomatoes, thin sliced onions, and cooked bacon.

Rhodes Pig

1 Loaf Rhodes
Bread,
(thawed, but
still cold)
Flour
1 Egg, Beaten
1 Raisin

Roll one loaf into large flat rectangle with rounded corners. Cut one corner off as shown. Divide corner piece into two large pieces and one very small piece. Roll one large piece into a flat rectangle and cut into two triangles for ears. Attach short base of ears to head, one on top of dough and fold tip over, and one underneath folding tip under. Shape the other large piece into 4 tear drops and slice toes as shown. Position under body. Roll small piece into a rope and curl for tail. Position on pig. Add raisin for eye and cut mouth. Brush with beaten egg. Cover with plastic wrap and allow to rise for 30 minutes. Remove wrap. Bake at 350°F for 20 minutes or until golden brown.



This little handi tracker was demonstrated at our last meeting. Many people have asked how to get into DF (direction finding). Here is a good way to start.

HOMING IN

Joe Moell, PE K00V
PO Box 2508
Fullerton, CA 92633

RDFing— A Growing Sport

In recent months, the mail has brought letters and phone calls about RDFing from all over the USA, Hawaii to Maine, Canada, Malaysia, Italy, Iran, Sweden, and Brazil. I've had the pleasure of giving talks on ham RDF to about twenty clubs, and telling about it on a nationwide radio show. New hunt groups are forming constantly, and they're having a great time.

Homing In would like to hear about your hunts, too. So help fill my mailbox even more. Include an SASE, and I'll send you a bibliography of recent books and articles related to transmitter hunting.

What's a TDOA?

Until now, I've discussed only single-antenna RDF systems, such as yagis, quads, and loops. They're great for locating weak or strong signals of just about any mode when the transmitter power is steady. But sometimes the signal amplitude isn't constant. When the S-meter is bouncing around so much that you can't tell when you're pointing the beam or quad at the signal source, you know it's time for a different kind of RDF system.

Over the years, a number of RDF schemes evolved that ignore the ups and downs of the incoming signal. They all involve the use of multiple antennas and comparisons of the signal that the hidden T puts into each one.

Switched-pattern DFs (such as the L-Per and Happy Flyer) and ring antenna units (such as Adcocks and Dopplers) are examples of well-known multiple antenna schemes. I'll cover these in future columns. This month, we'll look at a system that has a simpler principle of operation—the time-difference-of-arrival, (TDOA) antenna system.

Figure 1 shows a simple TDOA array, consisting of two vertical dipoles at the ends of a horizontal bar, supported by a short mast. It's called a narrow-aperture TDOA because the dipoles are a half wavelength or less apart. The

direction of the incoming signal is determined by comparing the signals at the whip. Note that the signal from Transmitter #1 arrives at Antenna A before it arrives at Antenna B. Conversely, the signal from Transmitter #3 arrives at Antenna B before Antenna A. The signal from Transmitter #2 arrives at both antennas simultaneously.

Some sophisticated military RDF systems use this TDOA principle to get highly accurate bear-

ings at fixed-site radio direction finding (RDF) installations for the HF bands. Even the elevation angle of arrival above the horizon can be determined, giving an idea of the distance of skip-propagated signals. But resolving ambiguities, determining elevation, and achieving high accuracy in a non-rotating system requires at least three antennas and a large, fast computer for signal processing. We're talking megabucks, so that's not practical for ham radio use, at least not yet.

But there's a well-known characteristic of FM detectors that makes the rotatable TDOA array of Figure 1 a useful tool for VHF

ham radio T-hunting with very simple signal processing. Feed the two antenna coaxes to an FM receiver through a selector switch, and then toggle that switch between the two antennas very rapidly, say 500 times per second. If the signals aren't arriving at both antennas at exactly the same time, there's an abrupt phase jump during switching, which the FM discriminator interprets as a frequency change.

Antenna switching occurs at an audio rate, so the apparent frequency change produces a superimposed tone on the received audio. The tone frequency remains constant at the switching rate, but the tone amplitude increases with the increasing phase difference between the signals arriving at the two antennas. The goal is to get a tone of minimum amplitude; this occurs when the antennas are equidistant from the signal source. At this point, the tone should disappear altogether. Other null patterns are possible using delay lines in individual antenna paths.

Build the "Handy Tracker"

Photo A shows how simple a DF set like this can be. This unit connects to your handy-talkie or scanner, and you rotate it by hand to take bearings. You could also mount it on a mast and use it for mobile hunting.

If you've used a loop and switchable sense antenna for direction finding on HF or VHF, you'll feel right at home with the Handy Tracker. Operation is basically the same. The difference is that a loop requires measurement of the signal strength, which

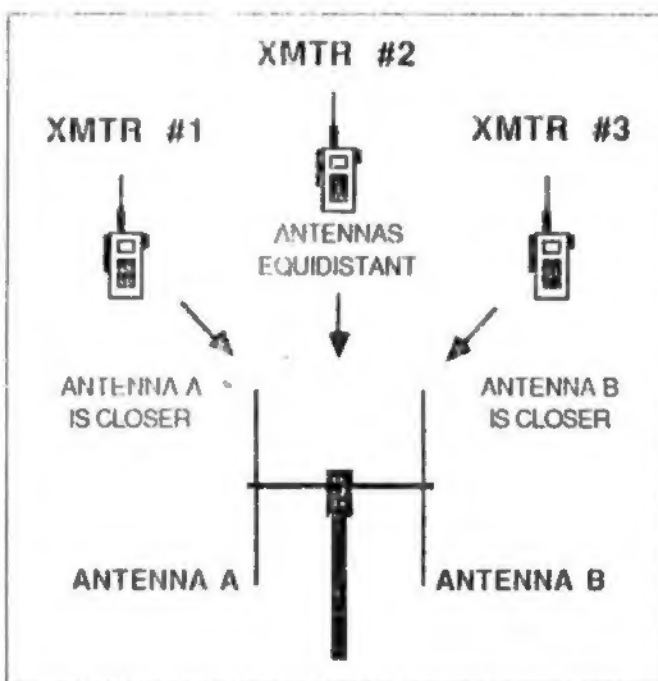


Figure 1 A TDOA RDF system tells direction by determining which of its antennas is closest to the transmitter.

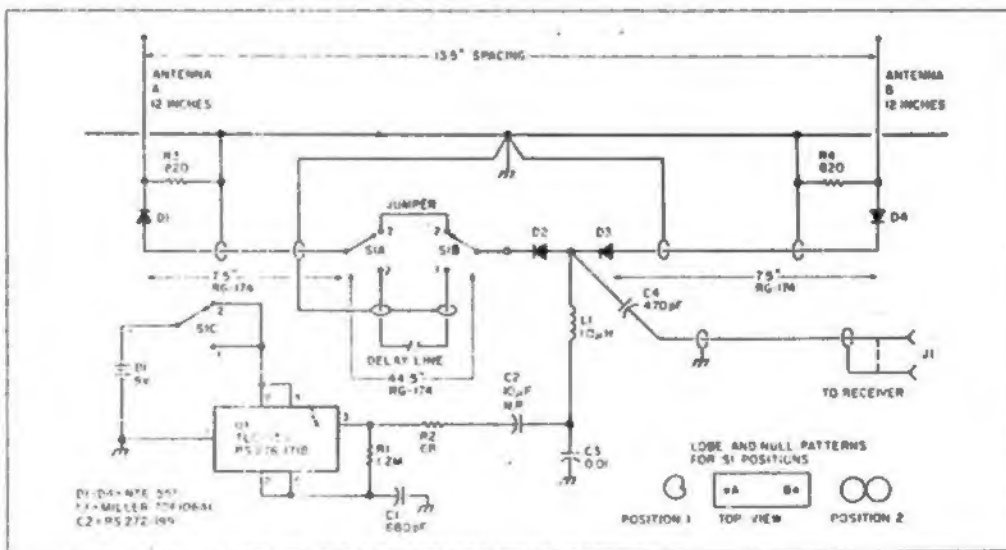


Figure 2. Schematic for the Handy Tracker. Dimensions shown here are for 2 meters. See text for replacement dimensions for 220 MHz.

Two Meter Three Element Quad

How To Build A 3 Element 2 Meter Quad
BY RUSS RENNAKER, W9CRC

There have been many articles written about 2 meter antennas, and I make no claims that this is the greatest. However, it is simple to make using readily available material, and it is very effective. I replaced a five-element Yagi with this quad, and it outperformed my Yagi noticeably. The support frame and the mast are made of 3/4" plastic tubing, which is available in any plumbing department. The elements are #9 hard-drawn aluminum wire, such as clothesline wire. Be sure it is not the soft drawn pliable kind.

The director wire is 80" long. The driven element is 84" long, and the reflector is 89" long. Make the driven element 3/4" longer (84-3/4"). This leaves 3/8" extra on each end to curl around the terminal bolts. All elements are bent into squares according to the dimensions shown in the drawing.

The tubing connectors at the three A's are standard "T" tubing connectors. The one at B is a four-way connector. The mast connector (between the driven element and the reflector) should be located as near to the

balancing point on the boom as possible. One way to do this is to place all three elements on the boom and locate the point of balance by suspending the whole thing over a thin piece of wood (or your finger) to find the center of balance. Then cut the boom at that point and insert the connector. Be sure to subtract the length of the connector from the length of the boom so it is still 34" long with the connector installed.

Drill out one section of the four-way connector at B so that it slides over the boom tubing. Then adjust the location of the loop for lowest SWR before cementing to the boom. I got mine down to 1.1:1 at 144.91, our repeater frequency. Secure all the "T" connectors with the cement. Be sure they are all lined up correctly, because when the cement sets they will be unmovable.

Drill a 1/8" hole 1/2" from the end of each cross arm (except the driven element arm at C). Saw a slit from the end of the tubing to the hole. Be sure the slit is at right angles to the boom. When you have formed the squares for the loops, press the wire through the slit to the hole. Secure with a 6-32 bolt through the tubing between the wire and the end (see D).

We need to attach the terminal block C to the other end of the driven element cross arm. Saw a slot back 1" from the end of the tubing and secure the terminal block in the slot with two 6-32 bolts (see C in drawing). The 8-32 bolts are for attaching the #9 wire and the coax leads. Curl the wire around the heads of the bolts (remember that we added 3/8" to each end for this). Secure with a nut on the opposite side. Use two washers and a second nut to secure the coax leads to the terminals.

For the supporting mast we used 3/4" plastic tubing. It is pretty flimsy, however, so we inserted a 1/2" dowel rod in the tubing to stiffen it. You may have other ideas, but the mast should be of a non-metallic material. It should extend well below the elements. I made mine 5 feet long and placed it on top of my triband beam.

My quad has withstood some very high winds, ice, and birds, all of which were hazards with the Yagi I previously used. The front-to-back ratio is excellent, and the range is better than the Yagi by a good 10 percent.

